DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

FIRST DESTINATION TRANSPORTATION (FDT) COST MODEL

by

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COMPUTATION, MATHEMATICS AND LOGISTICS DEPARTMENT
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FIRST DESTINATION TRANSPORTATION (FDT) COST MODEL

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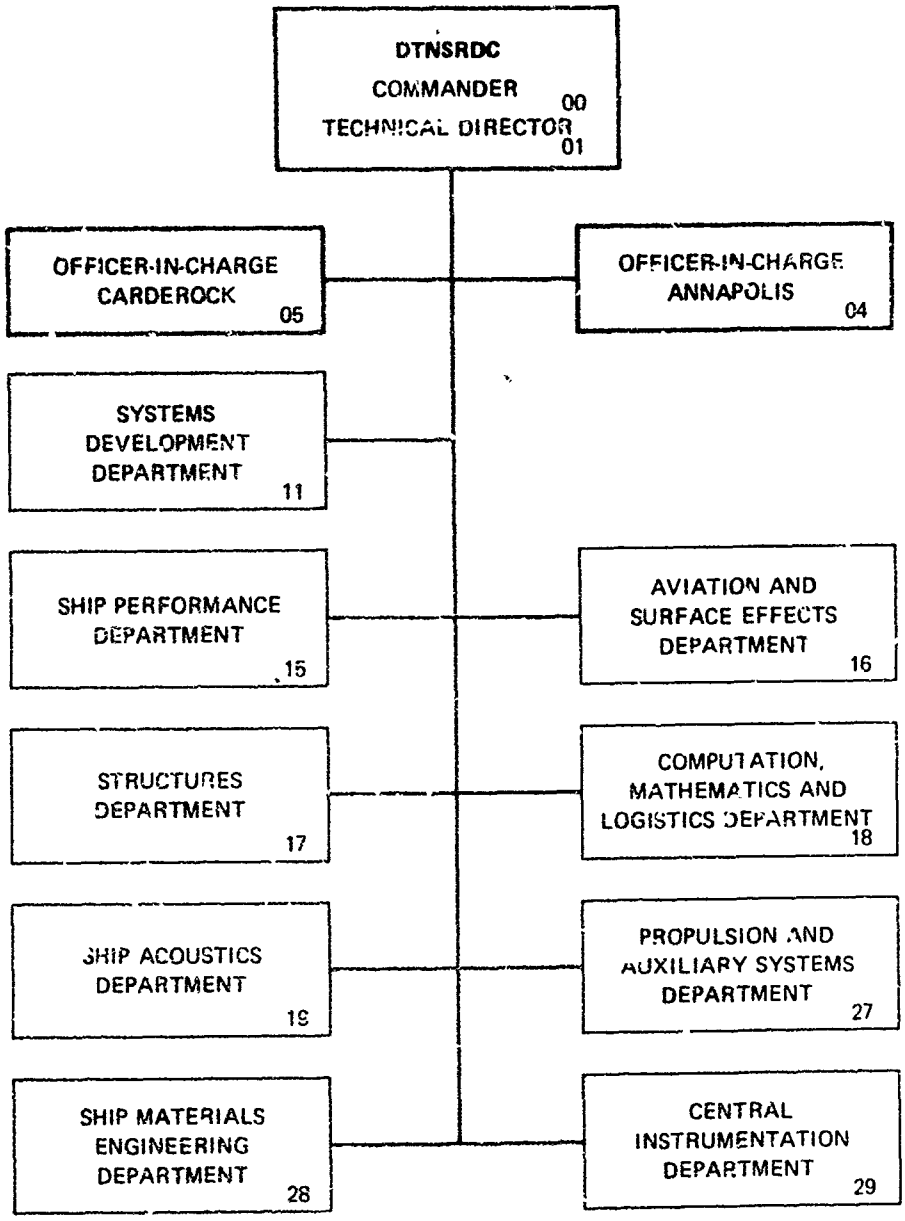

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The objective of this study was to develop a model that would forecast First Destination Transportation (FDT) costs for transportation budgeting purposes. Naval personnel from both Naval Supply Systems Command (NAVSUP) and David W. Taylor Naval Ship Research and Development Center (DTNSRDC) made a study of the Air Force's methodology for forecasting its FDT requirements. Actually, the required criteria for the Navy FDT forecasting requirements closely parallel those of the Air Force. Thus, the Air Force method could be adapted to Navy use if the required data were available.

The Air Force methodology is computer programmed. The program incorporates past and projected procurement data coupled with presently used transportation data.

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ABSTRACT

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The Air Force methodology is computer programmed. The program incorporates past and projected procurement data coupled with presently used transportation data.

ADMINISTRATIVE INFORMATION

The First Destination Transportation (FDT) model is needed to forecast Navy FDT requirements. The study was initiated in FY81. This was a joint effort by the Naval Supply Systems Command (NAVSUP 043/054E) and the David W. Taylor Naval Ship Research and Development Center (Code 187). The study was furded by NAVSUP 043 under Work Unit 1871-411 and Program Element 62760N. The Logistics Division (Code 187) of the Computation, Mathematics and Logistics Department (Code 18) was the performing organization.

INTRODUCTION

BACKGROUND

First Destination Transportation (FDT) costs are those incurred for transporting an item from the manufacturer to the first place of use or storage. The Naval Supply Systems Command (NAVSUP 054) requested that DTNSRDC develop a method to forecast FDT requirements. The present method of preparing the FDT budget request is based only on the previous year's budget and the experience of the individuals preparing the budget. In today's environment of closely scrutinized money programs, this present method of developing the FDT budget is inadequate. The new method will incorporate both past and projected procurement data, as well as the presently used transportation data, and will be structured by a budget commodity area. An additional requirement is that the new method be automated whenever possible.

The Air Force has completed and is using a satisfactory method to forecast its FDT requirements. Required criteria for the Navy FDT forecasting method closely parallel those of the Air Force. In June 1981, personnel from both NAVSUP and DTNSRDC visited Wright Patterson Air Force Base, Dayton, Ohio to discuss the Air Force method.

After a study of the Air Force method, it appeared that this could be adapted for Navy use if the required data were available. During the feasibility study, the appropriate data bases were not completely identified. The recommendation of the study is that the Navy proceed with the adaptation of the method and with data acquisition.

OBJECTIVE

Develop a model which will forecast FDT requirements for transportation budgeting purposes.

SCOPE

This study is limited to four basic procurement appropriations: Aircraft Procurement, Navy (APN); Weapons Procurement, Navy (WPN); Shipbuilding and Conversion, Navy (SCN); and Other Procurement, Navy (OPN).

METHODOLOGY

To estimate FDT requirements for specific years for a given procurement appropriation, the U.S. Air Force uses the following method: First, specify the years (2 years) for which FDT requirements are required. Then consider a 6-year period of historical data immediately preceding the specified years for which FDT requirements are needed. Included in these data are procurement years, procurement program (dollars) for each procurement year, deliveries (dollar amount), and FDT costs for the last 3 years in the 6-year cycle. The deliveries are based on each year's procurement program. FDT requirements for each procurement appropriation must be estimated separately.

The first step in the process is to compute "FDT factors." The delivery data for each procurement program are arranged according to "year deliveries" within the cycle. The deliveries are totalled separately by delivery year for each of the last 3 years in the cycle. To compute the FDT factor for a given delivery year, the FDT cost for that year is divided by the total deliveries for the same year.

Table 1 depicts a 6-year period of historical data (FY79 through FY84). FDT requirements are to be estimated for FY85 and FY86.

TABLE 1 - DELIVERY SCHEDULE FOR PROCUREMENT PROGRAMS

Procurement		Deliveries					
Year	Program	FY79	FY80	FY81	FY82	FY83	FY84
FY79	D_1	d_{11}	d_{12}	d_{13}	d_{14}	d_{15}	d_{16}
FY80	D_2		d_{21}	d_{22}	d_{23}	d_{24}	d_{25}
FY81	D_3			d_{31}	d_{32}	d_{33}	d_{34}
FY82	D_4				d_{41}	d_{42}	d_{43}
FY83	D_5					d_{51}	d_{52}
FY84	D_6						d_{61}
Total					d_4	d_5	d_6
FDT Cost					C_4	C_5	C_6
FDT Factor					F_4	F_5	F_6

D_j represents procurement programs; d_{ij} represents deliveries, where j is the delivery for a specified year for program i.

$$\text{FDT Factor} = \frac{C_i}{d_i} = F_i$$

where C_i is FDT cost per year and d_i is total delivery per year.
The cumulative FDT factor is computed by the following formula:

$$CF = \frac{C_{N-1}+C_N}{d_{N-1}+d_N}$$

where N = number of years in delivery cycle, and CF is the FDT cost factor used in computing FDT requirements.

The second step is to build an accumulative array of deliveries. For each annual procurement program, the sum of deliveries during that year is the first entity of the array. This sum is added to the second year's deliveries to form the second entity of the array. This cumulative process is continued throughout the 6-year cycle, e.g.,

$$(c_{11} = d_{11},\ c_{12} = c_{11}+d_{12},\ c_{13} = c_{12}+d_{13}\ldots)$$

This array is used for input in the next step (see Table 2).

TABLE 2 - CUMULATIVE DELIVERIES FOR PROCUREMENT PROGRAMS

Procurement		Cumulative Deliveries					
Year	Program	FY79	FY80	FY81	FY82	FY83	FY84
FY79	D_1	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}	c_{16}
FY80	D_2		c_{21}	c_{22}	c_{23}	c_{24}	c_{25}
FY81	D_3			c_{31}	c_{32}	c_{33}	c_{34}
FY82	D_4				c_{41}	c_{42}	c_{43}
FY83	D_5					c_{51}	c_{52}
FY84	D_6						c_{61}

The third step is to rearrange the cumulative array such that all first-year entities per procurement program are elements of a first delivery column. Next, all second-year entities are elements of a second delivery column, etc. This is continued throughout the 6-year cycle. Each column is added independently, thus yielding $T_1, T_2, \ldots T_6$ (see Table 3).

TABLE 3 - TOTAL ORDINAL CUMULATIVE DELIVERIES

Year	Deliveries					
	1st	2nd	3rd	4th	5th	6th
FY79	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}	c_{16}
FY80	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}	
FY81	c_{31}	c_{32}	c_{33}	c_{34}		
FY82	c_{41}	c_{42}	c_{43}			
FY83	c_{51}	c_{52}				
FY84	c_{61}					
Total	T_1	T_2	T_3	T_4	T_5	T_6

The objective at this point is to determine cumulative and annual delivery percent for each procurement year. To do this, one needs the cumulative of the annual procurement program by procurement year. This may be stated as follows:

$$CT_1 = D_1,\ CT_2 = CT_1+D_2,\ldots,CT_6 = CT_5+D_6$$

To obtain cumulative percent (X) we use the following formula

$$X_i = \frac{T_i}{CT_{(N+1)-i}},\quad \text{where } i = 1,\ldots N;\ N = \text{number of years in cycle}$$

Annual percent (P) is

$$P_i = X_i - X_{i-1},\quad \text{where } X_0 = 0;\ i = 1\ldots N$$

The fourth step in this method is to determine the undeliveries at the end of the 6-year cycle for each procurement program. This may be done two ways. One way is to use actual historical data; another is to use the following formula

$$U_i = D_i - c_{i,[(N+1)-i]}$$

where i = 1...N

U = undeliveries

N = number of years in data cycle

In order to obtain estimated deliveries for specified years, first let $U_{N+1} = D_{N+1}$ (procurement program for first specified year FY85). The total estimated deliveries (TED) for FY85 is

$$TED1 = \sum_{i}^{N} U_{[(N+2)-i]} * P_i$$

To obtain TED for the second specified year (FY86), let $U_{N+2} = D_{N+2}$ (procurement program for FY86). The total estimated deliveries for FY86 is

$$TED2 = \sum_{i}^{N} U_{[(N+3)-i]} * P_i$$

In order to complete the FDT requirement, we use the cumulative FDT factor (CF), previously calculated, coupled with TED. Hence, the FDT requirement for a given appropriation for FY85 is

TED1*CF

and the FDT requirement for FY86 is

TED2*CF

DATA REQUIREMENT

To estimate FDT requirements, two types of data are required: FDT cost and FDT delivery data. Actual FDT cost data are required for the last 2 or 3 years in the delivery cycle. Delivery data for each appropriation must be defined for each

year in the delivery cycle. To reiterate, the delivery data are the dollar value of the items for each procurement program delivered per fiscal year, for each year in the delivery cycle.

At this writing, the sources for Navy-required FDT data are not well defined.

COMPUTER PROGRAM

The program is designed to estimate FDT costs for two consecutive years. These years are entered as program input. The program is a computer interpretation of the previously stated methodology, and there are 17 principal parameters, 14 of which are dimensioned. The program, written in FORTRAN IV, consists of about 170 lines and requires five sets of input data to yield the desired output.

INPUT

The first set of input data contains the parameters IF, IL, and IC. These are defined as:

IF -- the ordinal position of the first year in the delivery cycle. This number is usually one.

IL -- the ordinal position of the last year in the delivery cycle, e.g., if delivery cycle is 6 years, then IL is 6.

IC -- the number of years in delivery cycle.

The parameters IF, IL, and IC are whole numbers and are read into the computer in a three-space format, e.g., ΔΔ1 or ΔΔ6, where Δ represents a space.

The second set of required data is the names of the fiscal years in the delivery cycle plus the 2 years for which FDT requirements are needed, e.g., FY84. This set of data is read into the computer with a format that allows four characters per year.

The third set of required data is an array of procurement dollars corresponding to the years in the delivery cycle. Procurement dollars are expressed in millions of dollars to the nearest tenth. These values are read into the computer with a format that allows for seven characters per entry, and they are right-adjusted.

The fourth set of input is a two-dimensional array consisting of delivery data expressed in millions of dollars rounded to the nearest tenth. The first row entities are the deliveries by year for the procurement (dollars) program for the first year in the delivery cycle. The second row entities are the deliveries by

years, for years within the delivery cycle, for the procurement program during the second year. Continuing this process, the last-row entities are the deliveries by year in the delivery cycle for the procurement program during the last year in the cycle. A zero is entered for those places where delivery data are not applicable, e.g., delivery for procurement program for FY84 in FY83 delivery column. The delivery data are read into the computer in a format which allows for a maximum of six characters per entry, and they are right-adjusted.

The last set of required input is an array of FDT costs. This number of entities must not exceed the number of years in the delivery cycle. The last two entities in the array must consist of actual FDT costs for, and corresponding to, the last two years in the delivery cycle. The remaining entities will be either actual FDT cost, corresponding to fiscal year, or zero. The FDT cost data are read into the computer in a format which allows for a maximum of six characters per entry, and they are right-adjusted.

OUTPUT

The FDT requirement is an estimate of FDT cost for a future year. The output is in tabular form with two principal columns. The first column contains the years for which FDT requirements are desired. The second column contains the FDT cost estimates in millions of dollars.

EXAMPLE

The following example illustrates the advantage of using the computer program. Data for this example table were taken from an Air Force data base and used as input for the newly designed computer program. The table of data used follows: IF = 1, IL = 6, IC = 6.

Procurement		Deliveries					
Year	Program (M$)	FY75	FY76	FY77	FY78	FY79	FY80
FY75	1587.5	87.7	654.1	367.7	326.7	105.6	50.7
FY76	2135.0	0	188.7	570.1	731.2	218.2	67.8
FY77	2299.0	0	0	113.5	696.4	784.2	371.2
FY78	2245.7	0	0	0	106.1	627.7	821.8
FY79	2441.2	0	0	0	0	102.8	1077.7
FY80	2082.2	0	0	0	0	0	146.9
FDT Cost					2.4	3.0	3.3

The years for which FDT requirements are sought are FY81 and FY82.

The output is given in Table 4. Note that the computer program estimated FDT costs are compatible with those of previous years.

TABLE 4 - ESTIMATED FDT REQUIREMENTS

Year	Cost ($ million)
FY81	3.6
FY82	4.9

SUMMARY

The study was composed of four phases: feasibility, data development, program development, and documentation. The feasibility of adopting the Air Force method for Navy use was carefully studied and found to have merit toward satisfying Navy FDT requirements. Hence, the methodology was adopted for Navy use.

Sources to provide data applicable for satisfying FDT requirements are not well defined. Transportation and procurement delivery data are required for this effort.

Computer programming of the Air Force methodology is complete. The program has been tested several times using Air Force FDT data and found to be highly satisfactory.

This report is the first documentation of this study.

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